

THE FEEDING OF TWO *Salamandra salamandra* (Linnaeus, 1758) POPULATIONS FROM JIULUI GORGE NATIONAL PARK (ROMANIA)

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Abstract. In the year 2008, we analyzed the trophic spectrum of a total number of 83 *Salamandra salamandra* individuals, captured from two habitats, Chitu and Ursului Valley. The salamanders consumed 964 animal preys, the most important ones being the Anelida-Oligocheta, Gasteropoda and Arahnida-Araneida. In the stomach contents, beside invertebrates, we had also identified vegetal fragments, shed skin and minerals.

Key words: *Salamandra salamandra*, feeding, prey taxa, habitats, National Park, Jiul Gorge, Romania.

INTRODUCTION

In Romania *Salamandra salamandra* it is considered to be vulnerable, encountered at altitudes starting with 200m (Cogălniceanu et al. 2000). In the last years new data regarding the distribution of this species showed that the altitude limit reaches even 150m altitude, in Satu Mare County (Covaciu-Marcov et al. 2007) or less, 135m in Arad County (Covaciu Marcov et al. 2008) or 100m on Danube Gorge (Covaciu-Marcov et al. 2009a).

In the Jiului Gorge National Park (J.G.N.P) *Salamandra salamandra* is a common species being recorded throughout the park (Covaciu-Marcov et al. 2009b) In the central parts of the gorge, there are numerous streams with a constant flow and calm areas, suitable for larval development. Despite the large number of individuals, the species is affected by anthropogenic impact with numerous specimens killed by cars being recorded (Covaciu-Marcov et al. 2009b).

In the Romanian scientific literature are few studies concerning the trophic spectrum of this species (Covaciu-Marcov et al. 2002, Cicort-Lucaciu et al. 2007a, Ferenți et al. 2008), but there are many studies published about other aspects concerning salamanders in other countries (eg: Egea Serrano et al. 2006, Dopzano & Korenblum 2000, Eitam et al. 2005). Quantitative information up on the role of the amphibians in the ecosystems are important (WHILES et al 2006), Thus a long time monitoring may offer useful information about the status of the habitat or about the positive or negative changes that occur in the biotope. The use of the food resources is a very important feature of the life history of a species, because it affects survival (Cuello et al. 2006). Data about the food composition of *Salamandra salamandra* in the J.G.N.P can be found in a single study made in autumn (Ferenți et al 2008). Thus, the present study presents new data about the trophic spectrum of *Salamandra salamandra* from J.G.N.P in the spring season.

MATERIAL AND METHODS

The samples were collected in the year 2008, from two habitats situated in the Defileul Jiului Natural Park. The two habitats are not very different, both being represented by valleys of cold and rocky streams, located in very dense forests with steep margins. The samples were collected in 15th of April, in the habitat from Ursului Valley we captured 42 salamanders, in the other one, Chitu Valley, 41 individuals were analyzed.

Stomach contents were collected using the stomach-flushing method (Solé et al. 2005). In this way, we can carry out feeding studies without killing the investigated individuals. The samples were preserved in separate airtight test tubes, which contain a 4% solution of formaldehyde. Afterwards, the salamanders were released close to the place where they were caught, in an attempt to diminish the impact that our activity could have on them. The preys found in the stomach contents were identified afterwards, in the laboratory, under a binocular magnifying glass. In order to determine the consumed prey taxa, we used the specialty literature (Crișan & Mureșan 1999). The parameters by which the trophic spectrum was analyzed are the percentage abundance (% A) and frequency of occurrence (% f) of the preys. To estimate the intensity of feeding we calculated the maximum and average number of preys / individual.

RESULTS AND DISCUSSIONS

In the stomach contents of the 83 captured individuals we identified a total number of 964 invertebrate preys (Table 1). In the case of the studied

populations we observed that all the individuals had stomach content, thus this being an indicator of the fact that in both habitats the salamanders have good feeding conditions (Sas et al. 2005). This indicates a rich trophic offer and also appropriate conditions for the development of the potential preys. Also in the case of the *Salamandra salamandra* population from Arad County (Cicort-Lucaciu et al. 2007a) all the individuals presented stomach contents.

Table 1.
The number of analyzed individuals. The total number of preys. The maximum and average number of preys/individual. The frequency of occurrence (%) of the vegetal fragments, shed-skin and minerals.

	Chitu Valley	Ursului Valley
No. of analyzed individuals	41	42
The total no. of preys	341	623
Max. no. of prey/individual	23	65
Aver. no. of prey /individual	8.31	14.83
% vegetal remains	73.17	80.95
% minerals	41.46	26.19
% shed-skin fragments	31.70	14.28

In the stomach contents of the analyzed salamanders we found beside animal preys, vegetal fragments, shed skin and minerals.

The shed skin fragments were found in the diet of both populations, but in habitat from Chitu Valley, 31.70% of the salamanders had ingested this type of food, while in the other habitat this was found in the stomach content of 14.28% of the salamanders. We consider that the salamanders consumed fragments from their own skin, taking in to account the fact that the individuals live at big distances one from another.

For what concerns the consumption of shed skin, some authors consider that these elements are consumed due to the amphibian's capacity to recycle their epidermal proteins (Weldon et al. 1993). At some Urodela was observed that the shed skin fragments are used as important food resources in the periods in which the animal prey taxa are found in reduced number or are hard to found (Cicort-Lucaciu et al. 2007b).

No individual consumed only vegetal fragments, this were present in the analyzed stomachs together with animal preys, this indicating the fact that the vegetal are ingested accidentally. Concerning the frequency of consumption of this fragments, in the habitat from Ursului Valley the value

reaches 80.55%, this being close to the value of 82.85% registered by Cicort-Lucaciu (2007). The vegetal are represented by dead leafs, grass, seeds, pieces of branches, swallowed by accident together with the animal preys, the adult amphibians being carnivores, thus the vegetal don't have any nutritional value. It can be observed that the vegetal are consumed by a large number of salamanders, also in the previous studies up on the feeding of this species effectuated in our country, the frequency of consumption is high (Covaciu-Marcov et al. 2002, Ferenti et al. 2008).

The accidental consumption of vegetal fragments along with other preys was reported as well in other *Salamandra salamandra* populations (Covaciu-Marcov et al. 2002, Cicort-Lucaciu et al. 2007a, Cicort-Lucaciu 2009), as with *Lyciasalamandra fazilae* species (Cicek et al. 2007), or with *Salamandrina terdigitata* (Utzeri et al. 2004).

The minerals are also ingested together with the animal prey, 41.46% of the individuals from Chitu valley had in their stomachs sand or small pieces of stones, in the other habitat the 26.19% of the population ingested minerals.

The population from Ursului Valley had a more intense feeding, the medium number of consumed prey was 14.83, while in the other habitat this parameter reaches only 8.31. In the previous study concerning the population from Chitu Valley the average number of preys/specimen of was 4.47 (Ferenti et al. 2008), lower that the one registered by us, thus in the period in which we carried out the samples prevailing the feeding conditions were much better that in the fall of the previous year.

The animal preys identified in the analyzed stomach contents were classified in 20 prey categories in the habitat from Chitu Valley in the other habitat we found a high number of prey categories, 28, here the trophic offer being more diverse.

Concerning the Miriapods, both Diplopods and Chilopods were identified in the diet of the salamanders. The Diplopods are present in the stomach contents in a greater amount and frequency than the Chilopods. This is due to the fact that the Diplopods are phytophagous forms, with reduced mobility, coiling their body as a defense method (Radu & Radu 1976) while the Chilopods are much faster, getting away by running or hiding under stones, pieces of wood. The Diplopods were consumed by a large number of individuals, in both habitats their frequency of consumption was high, but at Chitu Valley this taxon was consumed by 63.41% of the population (Table 2), while in the other studied habitat the value of this parameter was 47.61. The Diplopods represented in the habitat from Chitu Valley 12.02% from the total of consumed preys, in the other habitat this

prey category was ingested in smaller amounts by the individuals captured in the other habitat.

Table 2.
The percentage abundance (%A) and the frequency of occurrence (%f)
of the prey taxa (t. – terrestrial, L.- larvae).

	Chitu Valley		Ursului Valley	
	%A	%f	%A	%f
Anelida Oligochetae	21.40	58.53	63.08	76.19
Gasteropoda - snails	11.14	53.65	4.65	30.95
Gasteropoda - limax	20.23	70.73	10.11	66.66
Crustacea Isopoda	6.74	43.90	2.40	26.19
Arahnida Scorpionida	-	-	0.16	2.38
Arahnida-Pseudoscorpionida	-	-	0.16	2.38
Arahnida Araneida	5.86	34.14	2.72	30.95
Arahnide Opilionida	9.67	39.02	1.44	16.66
Miriapoda Diplopoda	12.02	63.41	4.97	47.61
Miriapoda Chilopoda	3.22	19.51	1.12	16.66
Colembola	0.58	4.87	0.16	2.38
Plecoptera	-	-	0.32	4.76
Plecoptera (L)	1.17	9.75	0.32	4.76
Ortoptera	-	-	0.80	11.90
Homoptera Cicadelloidae	-	-	0.16	2.38
Heteroptera (t)	0.29	2.43	0.80	11.90
Coleoptera - undet.	1.75	14.63	0.32	4.76
Coleoptera Coccinellidae	-	-	0.32	4.76
Coleoptera Elateridae	0.58	4.87	-	-
Coleoptera Curculionidae	0.29	2.43	-	-
Coleoptera Carabidae	0.29	2.43	0.96	14.28
Coleoptera Cryzomelidae	-	-	0.32	4.76
Coleoptera Lampyridae	0.58	4.87	0.80	9.52
Lepidoptera	-	-	0.16	2.38
Lepidoptera (L)	2.34	12.19	1.60	21.42
Trichoptera	0.29	2.43	-	-
Diptera Nematocera	0.58	4.87	0.48	2.38
Diptera Nematocera -Tipulidae	0.29	2.43	-	-
Diptera Brahicera	-	-	0.16	2.38
Diptera Brahicera (L)	-	-	0.32	2.38
Hymenoptera unnedet.	0.58	4.87	0.80	11.90
Hymenoptera Formicidae	-	-	0.32	4.76

The Gasteropods are the most important prey taxa in the trophic spectrum of the of studied populations, this invertebrates are common in the humid areas being found in large amount, and by a great number of salamanders. From this category the limax forms are consumed in both habitats by over 60% of the populations. The high amount of this prey type is not surprising because this move slow and doesn't have any possibilities to avoid the predators. The Limax have an amount of 20.23% in the first habitat, in the one from Valea Ursului the amount is 10.11%. It can be observed that also in the study carried out a year before (Ferenți et al. 2008) on Chitu Valley the Limax were consumed in greater quantity than the snails. It is considered that terrestrial Gastropods represent a key element of the trophic spectrum for salamanders (Zakrzewski & Kepa 1981, Covaciu-Marcov et al. 2002, Cicort-Lucaciu et al. 2007a).

The amount of the Gasteropods is lower in the habitat from Ursului Valley, here the most important prey taxon is represented by the Oligocheta, which has similar environmental requirements, in both habitats being found in large quantities and having a uniform distribution, thus the frequency of consumption is high.

The amount of the Oligocheta was 21.40 in the habitat from Chitu, in the other habitat the value of this parameter was higher, reaching 63.08. Concerning the frequency of this prey taxa, in the first habitat the Anelida were consumed by 58.53 of the population, while in the second habitat 76.19% of the individuals consumed this type of prey. The presence of this prey taxa was predictable, because they live in humid zones and are also easy to capture. In the previous study effectuated in the year 2007 in the same location, Chitu Valley (Ferenți et al. 2008) the amount of this prey taxa was more reduced, representing only 12.29% of the total number of preys (Table 2). This prey taxa was identified in the trophic spectrum of other salamandra population (Szabo 1962).

The Izopoda had on Chitu Valley an amount of 6.74% and a frequency of consumption 43.90%, in the other habitat this Crustaceans represented only 2.40% of the animal preys, and were found in the stomach of 26.19% of the population. The Izopods are also forms that live in humid areas, thus accessible for the salamanders.

The Araneids were present in the diet of both populations but at Chitu the amount and frequency of this prey is higher compared to the other habitat. In the first habitat 5,86% of the preys are spiders, while in the one from Ursului Valley, the amount of the spiders is 2.40%. Thus the values of the frequency are quite close, the Araneids being found all over the habitat, but in reduced quantities. The spiders were identified in the trophic spectrum of the population studied before in our country (Covaciu-Marcov

et al. 2002, Cicort-Lucaciu et al. 2007a, Ferenti et al. 2008) this type of prey being widely spread in nature.

The preys connected to the forest environment (Araneida, Opiliones, Diplopoda) are predominant, and also preys characteristic to wet lands (Anelida, Gastropods). This is due to the environment they live in, using the most accessible food resources from this environment. The consumption of forest preys was mentioned about other *Salamandra salamandra* populations as well (Cicort-Lucaciu et al. 2007a).

Coleoptera represents a taxon identified in both habitats. The adults belong to the next families: Coccinelidae, Elateridae, Carabidae, Curculionidae, Crizomelidae, Lampyridae. Undeterminate Coleoptera have the largest amount on Chitu Valley 1.75%, in the other habitat the value decreases 0.32%. Coccinelidae and Crizomelidae were not found in the diet of the individuals from Chitu Valley, and the Elateridae and Curculionidae are missing from Ursului Valley (Table 2).

An interesting presence in the trophic spectrum of population we analyzed are the Plecoptera and Trichoptera larvae. In the study carried out in 2007 (Ferenti et al. 2008) the aquatic preys were missing from the trophic spectrum, but the period in which the study was realized is different. Thus the presence of the aquatic preys, in our case, is due to the fact that the samples were collected in April, in the period in which the salamanders are laying the larvae. In this period, the salamanders can be found near the water stream, having access to the aquatic preys situated in on the banks. In the case of Plecoptera they can ingest individuals in the last larval stage, which are living the aquatic environment and are fixated on different substratum in the vicinity of the water, before passing in the Imago stage (Crian & Murean 1999). The Plecoptera live in well-oxygenated water and they are very susceptible to human abuse of water courses, any effluent that reduces the oxygen content of the water quickly extirpates them (Baumann R.W. 1979). Plecoptera, then, as a whole serve as indicators of healthy streams and rivers.

The Lepidoptera larvae were consumed by both populations, in the habitat from Ursului Valley by 21.42% of the individuals, this preys being easy to catch, and have high nutritional value being rich in lipids. Although the preys with reduced mobility are the most important for the trophic spectrum of this species (Luthard & Roth 1979) fact confirmed also by the dates obtained by us, in the diet of the salamanders were present high mobility preys like Nematocera and Brahicera (Covaciu-Marcov et al. 2002, Cicort-Lucaciu et al. 2007a).

CONCLUSIONS

In the trophic spectrum of the two analyzed populations we didn't found major differences depending on the location of the studied populations. The similar characteristics of the two habitats determined the development, in large quantities, of the same groups of preys. *Salamandra salamandra* is a polyphagous predator, hunting for the most accessible preys from its habitat.

Salamanders have low mobility, thus, the most important prey categories were the ones with reduced mobility like Oligocheta, Gasteropoda or Diplopoda. The preys connected to the forest environment (Araneida, Opiliones, Diplopoda) are predominant, and also preys characteristic to wet lands. The majority of the identified preys were from the terrestrial environment, but we have also found aquatic preys captured from the banks of the water. The absence of the empty stomachs indicates optimal feeding conditions for the two populations, and also adequate conditions for the development of the potential preys.

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